Albumin-coated vascular prostheses: A five-year follow-up

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In June 1989, we set out to implant 200 albumin-coated aortic bifurcation grafts and to track the patients for a period of 5 years to determine whether coating the prosthesis with albumin affected the patency or the incidence of complication. Two hundred and one prostheses were implanted between June 1989 and July 1991. The primary and secondary patency at 5 years was 95% and 98%, respectively. No relation between gender and patency or between the state of the runoff and patency was found, but there was a statistically significant relation between age and patency ($p = 0.00$). Graft infection was recorded in three patients (1.5%). There were no instances of bleeding through the graft at the time of implantation. The mean intra- and postoperative blood requirement was 2 units. There have been no incidences of false aneurysm in the groin. We conclude that there are no disadvantages of coating the prosthesis with albumin, and a trial of coated versus uncoated prostheses would be impractical. (J Vasc Surg 1996;23:686-90.)

Vascular prostheses made from inert polymers were introduced in the 1950s and were originally made from Dacron or Teflon woven or knitted into tubes. They proved to be satisfactory replacements for the abdominal aorta and iliac arteries in patients with extensive arteriosclerosis and occlusions or aneurysms of these arteries.[1-6]

The basic polymers were essentially nonbiodegradable, early complications were few (other than infection), and late-stage occlusions were associated with poor runoff, progression of disease, or buildup of a pseudointimal lining. Such prostheses seldom, if ever, healed completely with the formation of a confluent neointima, and much of the inner surface was covered with a pseudointima composed of fibrin and cells.[7-9] The concept of making prostheses more porous arose from work that equated healing with porosity, and the idea of a porous lattice through which a microcapillary network could nourish a functioning neointima was attractive.[10,11] The drawback was that the porous prostheses had to be preclotted at the time of implantation.[12]

Coating a Dacron velour prosthesis with a biodegradable substance that renders it temporarily impermeable has been shown to reduce bleeding at implantation.[13-16] Such a coating should reduce blood loss at implantation without introducing other complications, e.g., late-stage bleeding when the coating is absorbed, increase in infection rate, reduction in patency, and increase in false aneurysms, and it should not render the polymer biodegradable.

We know that the long-term patency rate of aortic bifurcation grafts is excellent.[17,18] What we do not know is whether by incorporating a biodegradable coating with a prosthesis the incidence of infection will be altered, more false aneurysms may arise, or how long-term patency will be affected. Several clinical studies have been carried out by using collagen or gelatin as a coating, but no long-term studies on albumin-coated grafts are available.[19,20]

We have monitored 199 patients who had an albumin-coated knitted Dacron prosthesis inserted between June 1989 and July 1991. Our aim was to find out whether the incidence of complications was similar to what we could anticipate from our own experience and historic comparisons.

PATIENTS AND METHODS

From June 1989 to July 1991, 201 human albumin-coated Dacron knitted velour prostheses (Bard VSCI, Billerica, Mass.) were used to bypass the aorta and iliac arteries in 201 patients. Only occasionally was anything other than a 16 mm × 8 mm bifurcation graft used (range 16 to 20 mm). There were 151 men (75%) and 50 women (25%) whose ages ranged from

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31 to 84 years, with a mean of 65.5 years. One hundred and two operations were performed for arteriosclerotic occlusive disease, and the remaining 99 were for abdominal aortic aneurysms. All operations were done in one unit, and the method of preparation and operation were the same in all operations. Operations performed for ruptured aortic aneurysms were excluded.

In all cases the skin was washed and painted with iodine but not shaved. In the operating room the skin was shaved, if necessary, then prepared with an alcohol solution of hibitane, then iodine. All patients were given a second-generation cephalosporin, 750 mg IV, at the time the anesthetic was administered. Patients were not given heparin systematically during the operation. The aorta was invariably exposed through a transverse abdominal incision. In all patients the proximal end of the prosthesis was sewn end-to-end to the aorta, then either end-to-end to the common iliac arteries or end-to-side to the common femoral arteries.

Antibiotics were continued after surgery, 750 mg IV at 12 and 24 hours. We recommended that all patients take 100 mg of aspirin daily from the date of discharge. Patients were evaluated at 6 weeks and at 3 months after operation, then at intervals of 6 months. The duration of follow-up varied from 6 years to 4 years. Mean follow-up time was 57 months.

Notes were made of any excessive bleeding at operation, leaking from the surface of the prostheses, and transfusion requirements. We looked for evidence of infection involving the prostheses, postoperative bleeding, the formation of false aneurysms in the groin, and patency. Patency was described as primary or secondary according to the criteria expressed in the Ad Hoc Committee on Reporting Standards.[21] Cox's regression analysis was used for statistical analysis of the collected data.

RESULTS

In the vast majority of patients, a 16 × 8 mm bifurcation graft was used. In 17 operations we used an 18 × 9 mm prosthesis and in four operations a 20 × 10 mm prosthesis. We used 4-0 Prolene (Ethicon, Ltd; Edinburgh, U.K.) for all anastomoses. Two patients died from myocardial infarction within 28 days of operation, leaving 199 patients available for follow-up. Of these, 102 had operations for arteriosclerotic occlusive disease, and 97 had aneurysms—i.e., 97 aortobiiliac grafts and 102 aortobifemoral grafts.

Intraoperative blood loss. There were no instances of bleeding through a prosthesis at the time of implantation. No bleeding occurred through any of the prostheses at the site at which clamps had been applied. Two patients had to be returned to surgery from the recovery room because of postoperative bleeding. In both patients, bleeding was from the suture line, not from the graft or from a needle puncture in the graft.

An average of 2 units of blood was given (mean intra- and postoperative requirement) to those patients who received blood transfusions (119), and no blood transfusion was given during or after surgery in 82 patients.

Infection. Evidence of infection in one groin was found in three patients and involved the prosthesis (1.5%). All these patients were in the arteriosclerotic occlusive disease group. One occurred 4 weeks after surgery and was caused by a methicillin-resistant *staphylococcus aureus*. The complication was treated by giving the patient rifampacin and covering the prosthesis with sartorius muscle. The infection resolved, and the graft remains patent 52 months after this episode. The second patient showed signs of infection in the groin 3 months after surgery. The infection responded to drainage, irrigation with iodine, and antibiotics. The graft was patent at the last follow-up, 4½ years after implantation. In the third patient, infection appeared to start 7 months after implantation; it failed to respond to antibiotics, and the prosthesis was removed and replaced with an axillobifemoral graft.

Patency. Only 10 patients had occlusion in one or the other limb of the bifurcated graft. Overall primary patency rate was 95%. All 10 patients were in the occlusive disease group. Fig. 1 shows, in the form of a life table, the difference in patency with time of the grafts in patients who had arteriosclerosis/occlusion and those who had aneurysms. The lines have been discontinued at the point where the number of observations fell below 20.

We recorded an occlusion of the superficial femoral artery distal to a reconstruction in 41 patients (41%) in the occlusive disease group. Of the 10 patients who had an occlusion, five had a blocked superficial femoral artery on the ipsilateral side. There was no statistically significant correlation between occlusion of a prosthesis and an occluded superficial femoral artery (Fig. 2). If we used limbs of bifurcation grafts rather than patients, the denominator in the occlusive disease group increases to 204, an incidence of occlusion of 5% in the group. Six of the 10 occlusions occurred approximately 3 years after operation.

Eight of the 10 occlusions were in male patients;

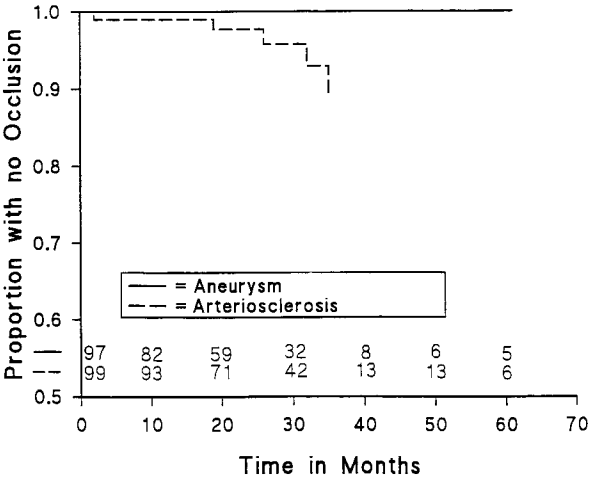

Fig. 1. Survival curve for diagnosis. Life table analysis—proportion of patients with occlusion vs time. Two groups based on diagnosis (aneurysm or arteriosclerosis). All figures indicate number of observations at each time interval.

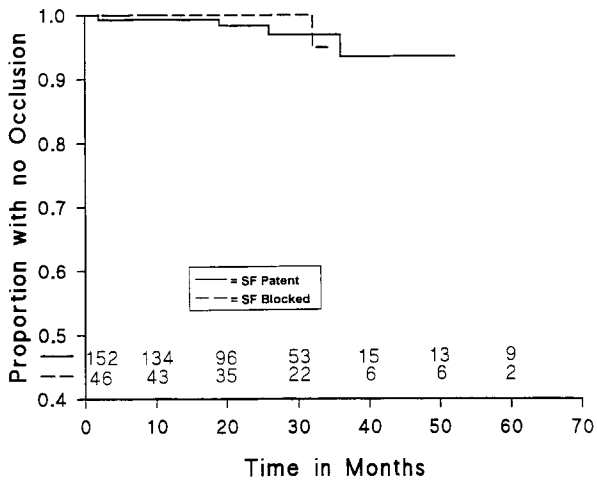

Fig. 2. Survival curve for superficial femoral artery occlusion. Two groups of patients with occlusion in superficial femoral artery on ipsilateral side and patients with patent superficial femoral arteries.

there was no relation between gender and occlusion (Fig. 3). Age, however, did have a statistically significant effect on occlusion; the older the patient, the less the risk of occlusion ($p = 0.00$) (Fig. 4). Of the 10 occluded grafts, patency was successfully restored in 7 patients (two patients by thrombectomy alone; 3 patients by thrombectomy and femoropopliteal bypass; 2 patients by extending the occluded limb of the graft from the iliac to the common femoral artery). The secondary patency rate was therefore 98.0%.

DISCUSSION

If by coating a prosthesis with a biodegradable substance (e.g., human serum albumin) one can reduce blood loss and avoid transfusion, the proposition is attractive to both surgeon and patient. It becomes less attractive, however, if the advantages are offset by an increased incidence of complications and reduction in long-term patency.

We chose not to do a randomized comparative trial because without knowing the incidence of complications we could not predict how many patients we might need. We anticipated that differences were likely to be small, and that to be certain of any difference at the 90% confidence level, we would probably need >2500 patients in each arm of a trial.

In the period set for the study, June 1989 to July 1991, we performed 201 aortic bifurcation grafts, which fulfilled the criteria for our study. We excluded patients who had emergency aortic surgery on the basis that some patients may have a coagulinopathy, and there was no preoperative skin preparation. We also excluded patients who had tube grafts and patients who had thoracoabdominal aneurysms, and hence very extensive grafts. Two patients had a myocardial infarction within 28 days of operation and died as a result. Because there were no immediate intraoperative complications associated with the prosthesis and because these patients were unavailable for long-term follow-up, we excluded them from the analysis. Nine patients had clinical or electrocardiographic evidence of an infarct within the first 28 days; they recovered fully and were included in the analysis. The incidence of myocardial infarction does not differ from that reported for similar operations in the preceding 4 years in our unit.[22] In this study of patients who had an aortic bifurcation graft, there were too few occlusions to allow us to perform multivariate analysis. Instead, we examined four covariates to test for a relation between the patient's gender, age, and underlying reason for operation (occlusion or aneurysm), to the patency rate of the superficial femoral artery and the incidence of complications. Although all 10 occlusions occurred in the occlusive disease group, the difference between the incidence of occlusion in the occlusive disease group compared with the aneurysm group was significant only at the 10% level ($p = 0.62$).

The long-term patency rate compares favorably with the results reported for other coated prostheses[19,20] and agrees with the short-term results reported by Branchereau et al.[16] who used similar prostheses.

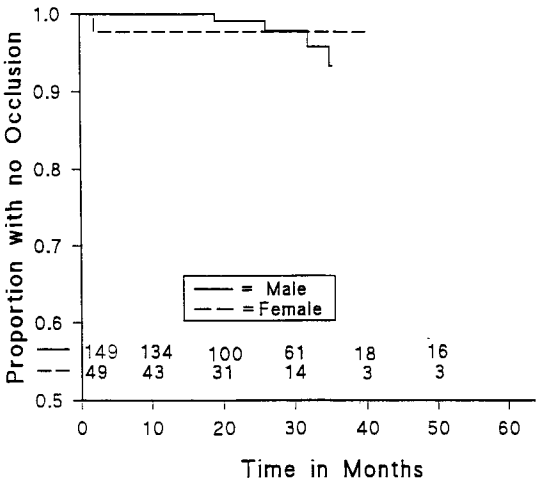

Fig. 3. Survival curve for gender. Two groups on basis of gender.

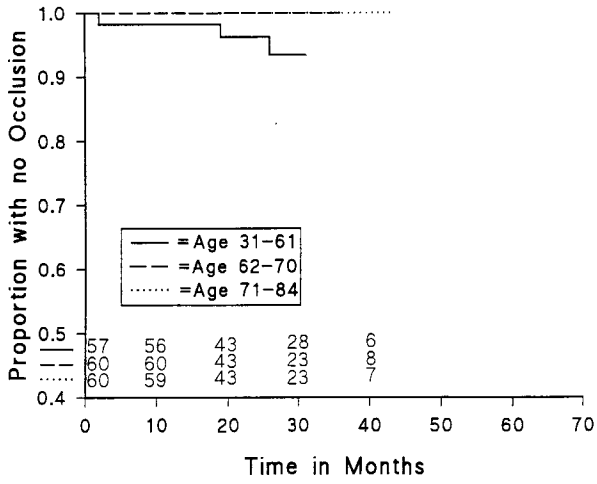

Fig. 4. Survival curve for age.

The results are also comparable with those reported from our unit when we used uncoated prostheses.[17] We found that age influenced the long-term patency of the grafts—the older the patient, the less likely the graft was to thrombose. However, all patients in the 71 to 84 age group had aneurysms, and it is likely that this finding reflects the reason for operation rather than some protective factor related to age. We know of no instances of aneurysmal dilatation of the prostheses or leakage that have occurred after an interval of time and that might indicate biodegradation of the polymer.

This series of 199 patients had a 1.5% incidence of graft infection, which could be expected when looking at the incidence of infection in vascular surgery.[11-13] No correlation between infection and any of the covariates we studied was found. So far, after a mean follow-up period of 4 years, there have been no false aneurysms at the junction between prosthesis and common femoral artery. By false aneurysm, we refer to the type that occurs without evidence of local infection to differentiate them from infected cases. Theoretically it may be possible to contract a viral infection from coatings derived from human serum albumin. We are not aware of any such infection having occurred in this group of patients. However, it is unlikely that a patient who contracted the human immunodeficiency virus (HIV) would show any clinical manifestations so far, and we have not tested for this possibility. We have not seen any patient contract hepatitis after insertion of a coated prosthesis. Transmission of a virus seems highly unlikely because the albumin used for coatings must meet stringent quality control standards and must be obtained from donors tested for HIV and hepatitis. The commercial preparation of coated grafts involves sterilization.

We concluded that the albumin-coated prosthesis provided the advantage of minimal blood loss without preclotting and did not pale in comparison with uncoated prostheses regarding infection, durability, and long-term patency. No apparent difference in patency was found between this series of albumin-coated grafts and a series of uncoated grafts previously published from this unit. We calculate that in view of the high patency rate, a trial of a coated graft against an uncoated graft would be impractical and is unnecessary.

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